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EVALUATING THE TEA MAP AND TELEPHONE SEARCH TESTS AS MEASURES OF SELECTIVE VISUAL ATTENTION IN CHRONIC APHASIC CLIENTS

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Abstract

Recent research has suggested that characteristics of aphasic behaviour may be related to attentional factors rather than linguistic impairments. Aphasic individuals are shown to have difficulty on attention tasks. Inefficient allocation of attention has been proposed to account for aphasic individuals poor performance on such tasks. Attention deficits can affect the accuracy of an individuals comprehension and production skills. Speed of processing influences performance on cognitive tasks and is shown to decrease post-stroke. Assessment of attention in an aphasic individual is essential to determine factors that may be a product of attentional impairment rather than purely linguistic factors. The usefulness of the 'test of everyday attention' (TEA) to measure selective attention deficits in the aphasic population was investigated. Selective attention sub-tests of the map and telephone test were selected. The rating scale of attention (RSA) provided a functional assessment of attention. A 'speed of processing test' was devised and data was collected from 80 non-brain-damaged volunteers for comparison. Language measures were taken to compare performance on the TEA tests to participant's linguistic impairments. Results showed that the TEA selected sub-tests provided a suitable tool for the clinician to measure selective attention deficits in aphasic individuals. However, the telephone test showed a highly significant relationship with linguistic measures suggesting that the map test may prove a more reliable measure of attention. Speed of processing was shown to affect some participant's performance on the TEA sub-tests. It remains unclear as to the extent that visual and motor impairments affected performance.

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Attention and Aphasia

1. 1 Introduction

Aphasic symptoms have been traditionally characterised by purely linguistic impairments (Murray 2003). However, recent literature suggests that attention deficits may interact with impaired language processing mechanisms to generate aphasic language (Coslett 2001). In particular, studies have shown that selective attention deficits can negatively affect the accuracy of an aphasic client's language comprehension and production skills (Murray 2002, La Pointe *et al* 1991). These studies have incorporated non-linguistic stimuli, so that identified attentional deficits can be attributed to attention factors, without influence by an aphasic subjects linguistic impairment.

Assessment of attention is essential to determine the behaviours that may be a product of attentional impairment rather than purely linguistic factors (Murray 2002). Unfortunately, many neuropsychological tests of attention are inappropriate to administer on the aphasic population due to their language impairments (Korda & Douglas 1997). The 'Test of Everyday Attention' (Robertson *et al*, 1996) and the 'Rating Scale of Attentional Behaviour' (Ponsford & Kinsella 1992) may provide the clinician with suitable measures to assess selective attention.

In this introduction, the concept of attention will be addressed alongside theories of attentional capacity limitations. This will include an overview of studies that have examined attentional capacity limitation and its interaction with language. Speed of processing post-stroke will be examined and related to attention deficits. The importance of assessing attention in an aphasic individual and recommended standardised tests for this population will be outlined. Linguistic considerations and factors that may influence performance on such tests will also be discussed.

1.2 Attention Systems

Posner and Peterson (1971) argued that attention consists of at least three separate systems or stages. The initial stage, orientation, typically refers to the physiological state of readiness by an organism. Vigilance or sustained attention is the second component of the general phenomena of attention. Vigilance refers to the ability to respond to infrequent events and is measured via continuous repetitive tasks (Murray, 2002). Selective attention is the third component and has greatest relevance to this context.

Selective attention refers to a set of mechanisms that enhance processing to attended stimuli or inhibit processing of irrelevant information (O'Donnell, 2002). It is necessary for all cognitive tasks in order to determine which aspect of a stimulus to attend. Studies investigating anatomical correlates of selective attention have used positron emission tomography (PET). PET studies of the selective attention system suggest that the frontal lobes are important in maintaining attention during selective attention tasks (Bench et al, 1993; Cohen et al. 1988). These tasks show prominent activation in the frontal cortex and the anterior cingulate in non-brain damaged subjects (Pardo *et al,* 1990).

Selective attention is vulnerable to disruption by focal lesions subsequent to a stroke (O'Donnell 2002). It has been well documented that individuals with right hemisphere strokes have some degree and form of attention deficit (Myers 1999). Research has also confirmed that individuals with left hemisphere brain damage have attention limitations (Korda & Douglas 1997).

Individuals with aphasia have been shown to display difficulties completing tasks that require selective attention. For example, Glosser and Goodglass (1990) investigated visual selective attention where aphasic subjects watched a continuous random sequence (200 trials) of 'X's and 'O's and were required to press a response bar for each occurrence of the pre-assigned target (either X or 0). This task placed demand both upon sustained and selective attention mechanisms. They found that aphasic participants; especially those with frontal lesions had difficulty performing on this task. As PET studies suggest selective attentional processes are located in the frontal lobes, a lesion to this region would explain such difficulties on this task. Additionally, Van Mourik *et al.* (1992) demonstrated that aphasic participants had difficulty on a cancellation task, requiring aphasic subjects to cross out a numerical value embedded within letter symbols, to examine visual selective attention. Of the 17 participants with global aphasia, six were unable to perform this task.

McNeil and colleagues (1991) have proposed that individuals with aphasia have difficulties with attention tasks, specifically those with language demands because of inefficient or inappropriate allocation of attentional resources. These researchers have also suggested that many characteristics of aphasic behaviour may be related to attention rather than linguistic impairments.

1.3 Allocation of Attention Theory

Attentional models depict attention as a capacity-limited system that can impact upon cognitive operations (Murray, 2003). Two assumptions are implicit a) there exists one or more pools of attentional resources that are finite and b) although attentional capacity is limited, the deployment of attention is assumed to be flexible in that the resources can be allocated to multiple tasks simultaneously (Coslett, 2001). The amount of attention invested in a cognitive task is dependent upon the task demand: the processing resources necessary to assure successful completion of the task (Murray, 2002). It must be noted that alternative models of attention that challenge capacity theories of attention have put forward. Pashler (1984;1994) argued that decrements in performance are attributable to attentional 'bottlenecks', which occur when dual tasks place demand upon the same cognitive operation. In this model, completion of one operation must wait or suffer.

Attention allocation deficits have been proposed to account for the greater magnitude of variability of performance, in subjects with aphasia. Linguistic models alone are unable to account for aphasic inconsistency of performance on a same stimulus task that is common among aphasic individuals (Kriendler & Fradis 1968, Tseng *et al.* 1993). According to McNeil (1983), all linguistic and cognitive operations supporting language are variable in persons with aphasia. This variability may result from brain damage or from the exacerbation of conditions that cause variable performance in non-brain damaged subjects under stress.

Clinicians can improve the language performance of aphasic clients by manipulating stimuli and contextual factors (Murray, 2003). Modifications may include assessing clients in quiet environments and slowing the presentation rate of a stimulus in order to maximise performance. However, it is unlikely that the manipulation of such factors would help the client relearn or restore a language process they have previously demonstrated (Murray, 2002). The interaction of impaired attentional resources and deficits in linguistic processing may account for variability typically observed in many clients with aphasia (King & Hux 1996).

1.4 Attention allocation and aphasia

The Capacity Limitations Model explains task competition for resources that takes place in response to a multitude of stimuli. In completing simultaneous tasks or 'dual tasks', performance decrements in one or more tasks are anticipated if the tasks compete for the same pool of resources. The more tasks that share this pool of resources, the greater the interference that is expected in these conditions.

Support for an attentional account for aphasia has been accumulated using dual-task paradigms. Studies have required individuals to complete a dual choice task assessing the effect of attentional load on performance (Korda & Douglas 1997, McNeil *et al.* 1997, Murray 1997 *et al.*, Tseng *et al.* 1993). These studies comprise of a linguistic task in competition with a non-linguistic task. Theoretically, the resource demands of the primary linguistic task do not change during the dual-task conditions (Murray, 2002). The aphasic participant's optimal performance should be observed during the single-task condition. The dual task paradigm assumes that when two tasks are performed together, they compete for attentional resources (Salthouse 1996). Attentional capacity limitations are reflected in the decline in performance on these tasks, as compared to the single task condition (Murray *et al.* 1997). Several researchers have examined attention deficits in relation to auditory comprehension and spoken language in aphasic subjects (Murray 1997 *et al.* , Murray *et al.* 1998, Tseng *et al.* 1993). To date little research has been conducted to assess aphasic adults reading comprehension using the dual task paradigm.

Results from dual task studies have suggested that attention deficits can negatively affect auditory comprehension even in mildly aphasic individuals. La Pointe and colleagues (1991) required individuals to complete an auditory vigilance task alone and in competition with a card-sorting task. The auditory-vigilance task involved identification of a target word randomly interspersed amongst other monosyllabic words, and the card-sorting task employed the Winsconsin Card Sorting Task (Grant & Berg 1981) according to colour. The aphasic and normal participants had similar accuracy scores on the auditory-vigilance task in isolation. However, under the dual task condition, the aphasic group performed significantly more poorly.

Murray *et al.* (1998) investigated deficits of attention and interaction with spoken language in mild aphasic and non-brain damaged subjects using a single and dual-task paradigm.

Participants performed a picture description task and a tone discrimination task under selective attention conditions. Subjects completed one task and were instructed to ignore the secondary, competing stimuli. During optimal listening conditions (single-task) there were little differences in accuracy between the control and aphasic participants. However, during the dual-task condition, the aphasic group showed greater performance decrements on linguistic measures than the control. They produced fewer syntactically complete and complex utterances, fewer words and poorer word-finding accuracy. This decline suggests that linguistic deficits in aphasia are associated with deficits of attentional capacity or allocation as opposed to a purely linguistic impairment alone.

Other methods that have been employed to examine the relationship between attentional resources and language have incorporated non-brain-damaged subjects to perform language tasks under adverse processing conditions (Bates *et al* 1994, Blackwell & Bates 1996). Adverse processing conditions that involve increasing the cognitive load of the task or decreasing the saliency of the linguistic stimuli are introduced to induce capacity limitations from which aphasic adults are proposed to suffer (Murray, 2002). Therefore, non-brain damaged participant's should display aphasic similarities in their language profile during these stressful conditions. Tew (1990) examined non-brain-damaged participant's performing a picture naming task under timed conditions. Subjects were required to name pictures as quickly as possible, sacrificing accuracy if necessary. Tew found that subjects who completed the task under timed conditions produced more naming errors than subjects who completed the task with no stress. These findings are consistent with the model of aphasia in which deficits of attentional capacity, its allocation, or both negatively interact with preserved language processes.

1.5 Selective attention deficits and language severity

As capacity of the mind is limited, selective attention enables the individual to select specific stimuli while ignoring other irrelevant information. The ability to selectively attend prevents cognitive systems from becoming overwhelmed by excessive demands on limited processing resources (Cohen *et al.* 1993). Mechanisms for selective attention interact with systems such as language to focus processing on relevant aspects of incoming information (Petry *et al* 1994).

These studies have demonstrated that attention allocation deficits in aphasic individuals have an important influence on auditory comprehension and production abilities. It has also been suggested that there may be a correlation between poor language skills and attention skills. (Korda & Douglas 1997; Kaizer *et al* 1988). However, no significant difference has been found between severity of auditory comprehension deficits and attentional capacity in aphasic subjects in studies that have been conducted to date.

Korda & Douglas (1997) emphasise that although it is reasonable to expect impaired attentional capacity to affect comprehension, the reverse relationship is not necessarily true. Individuals with impaired comprehension may not present with attentional capacity deficits, the impairment may be completely linguistic in nature.

Capacity limitations may be reflected in a slower rate of information processing. (O'Donnell 2002). The speed of which an aphasic participant completes a task provides a means of evaluating attention allocation efficiency. The participant's reaction time (RT) represents a behavioral measure of information processing (McKay *et al* 1989).

1.6 <u>Speed of processing</u>

Speed of processing is known to influence performance on cognitive tasks (Salthouse 1996). Reaction time (RT) experiments which split reaction time into a movement and a decision component have been used to investigate processing in aphasic subjects (Gerritsen, 2003).

Dee and van Allen (1973) used a 1-, 2-, 3-, and 4- choice visual reaction time task to investigate speed of processing. The stimuli consisted of coloured lights and the subjects were required to respond by pressing a button of corresponding colour with the ipsilateral hand. Both left and right hemisphere damaged subjects were slower than the control. Findings by Korda and Douglas (1997) and Gerristen (2003) revealed stroke patients demonstrated slower processing speed as shown by increased RT on visual tasks in comparison with the non-brain damaged group.

Although these investigations demonstrate increased reaction times in aphasic subjects, it is often unclear whether longer response times were reflective of slow processing or due to manual dexterity deficits that often occur as a result of stroke (Murray 2003). Poor visual and motor processing should be considered as this may impact upon a given participants reaction time response.

1.7 Visual and motor processing

Visual processing refers to the processing of information presented in pictorial or written forms (Bandur & Shevan 2001). It involves a *pre-attentive* phase that evaluates the visual scene and an *attentive* stage that requires search of the visual field for specific objects (O'Donnell, 2002). The pre-attentive stage segregates a visual scene on the basis of simple features such as colour and size. Identification of stimuli that are defined by conjunctions of features in the attentive stage requires selective attention. Furthermore, difficult discriminations can result in longer reaction times (Myers, 1999).

Visual acuity and visual field deficits can impact upon task performance, resulting in difficulties with visual attention and scanning (Bandur & Shevan, 2001). Lesions to the frontal or parietal lobes caused by a stroke may result in visual neglect. Visual neglect is characterised by a lack of awareness of visual stimuli in the contralateral visual field.

Hemianopia occurs as a result of a loss of half the vision in both eyes following stroke. There is clear evidence to suggest that reaction times are increased by neglect or hemianopia (Gerristen 2003).

Hemiplegia and hemiparesis are frequent following stroke and the patient does not recover the full use of their limb on the contralateral side (Gazzinaga 2002). Arm movement is limited and carried out by gross movements controlled by proximal joints such as the shoulder and the elbow (Gazzinaga 2002). Such weaknesses of the preferred hand or a reliance on their non-preferred hand may compromise the speed on non-verbal intelligence tests that require fine motor skills thereby reducing performance. (Van Mourik *et al.* 1992). The clinician should be aware of such impairments when assessing attention in aphasic individuals as they may negatively impact upon test results.

1.8 Assessing attention and Aphasia

As virtually all higher cognitive tasks require attention, it is an essential that clinicians should consider attentional issues when assessing aphasia. Subjective data about changes following stroke indicate that patients and their relatives rated mental slowness first on their list of cognitive complaints (Hochstenbach 1999). Attention impairments are a significant prognostic factor for success in rehabilitation and return to work (Ramsing *et al,* 1991). Additionally, reduced attention has proven to be a critical factor in the failure of treatments in therapy and it is imperative to extend diagnostic procedures to include the assessment of attention (Van. Mourik *et al* 1992). Speech and Language therapists must acknowledge that attention deficits and aphasia frequently occur together and familiarise themselves with assessments to address attentional impairments (Murray, 2002).

Various standardised assessments are available to investigate attention in aphasic clients. It is important to consider the linguistic variables that may affect scores on attention test. Murray (2002) suggests that the 'test of everyday attention' may be most useful in clinical practice as it assesses a variety of attentional functions and includes everyday life materials. Additionally, it has been standardised on a group of stroke participants although the number that had aphasia was not specified.

The 'test of everyday attention' directly assesses aspects of attention for adults 18 to 80 years of age. The normative sample consisted of a large sample of non-brain damaged adults alongside 74 unilateral stroke patients two months post stroke. It has been shown to have acceptable reliability for the selection of stroke patients (Robertson *et al* 1996). However, certain selective attention sub-tests involving reverse counting, such as the elevator test, would be unsuitable to administer on the aphasic population (Robertson *et al.* 1996). Furthermore, poor language skills may influence performance on these tasks and modification of task instructions may be required (Murray 2003).

The TEA map search and telephone test are sensitive to a visual selective attention deficit. These subtests involve visual search for predetermined targets against competing and irrelevant foils. Both tasks require active inhibition of competing distracters and selective activation of the target representation (Robertson *et al* 1996). Robertson *et al* (1996) acknowledges that as the sub-tests have a timed element, speed of processing may play a part in performance.

Robertson *et al.* (1996) examined the relationship between these tests and the rating scale of attentional behaviour (RSA). The RSA is a questionnaire used to measure functional attention and is completed by the aphasic patient's clinician. It provides information about how attentional impairments may be impacting upon the patient in daily life. The questions investigate selective, divided and focused attention and give an overall total score for attentional behaviour. Robertson *et al.* (1996) found that the map search test correlated with this measure.

1.9 Investigations of the TEA and Aphasia

Bamber (2005) investigated the usefulness of the TEA to measure selective attention deficits that may be present within the chronic aphasic population. Data from 16 aphasic chronic volunteers was collected in a clinic. The TEA map and telephone search were selected as they purport to measure visual selective attention deficits. Ratings of observed attentional impairments were also collected as a functional measure of attention. Significant correlations were found between observed attentional impairments (RSA) and both the map and telephone sub-tests. However, no significant correlations were found between performances on the two TEA sub-tests.

Bamber (2005) attempted to consider factors other than selective attention that may have influenced performance on the TEA sub-tests. Specifically, the severity of the aphasic client's language characteristics and processing speed. Analysis of language was restricted to qualitative analysis based upon syndrome labels of which no clear patterns emerged.

Response speed was measured by the 'speed of processing test'. This test was devised for this study in order to measure speed of visual and motor processing. Speed of processing is critical to the TEA scores. The speed of processing test is based upon the TEA map search test, using symbols of identical size and distribution, with the distracting visual information removed. The TEA takes into account normal age related changes in speed of processing using comparison to age related data. This project attempted to investigate whether or not speed of processing changes post-stroke, over and above the normal age related changes, to influence performance on these sub-tests. Although only a small normative sample was collected (n=23 participants), preliminarily analysis suggested that speed of processing may have influenced test scores for some of the aphasic participants.

1.10 Aims of the study

The aims of this study are to further investigate the relationship between the TEA scores and aphasic language characteristics. The data from selected participant's language western aphasia batteries (WAB) (Kertez 1982) will be used to investigate the relationship between language measures and the TEA scores. Speed of processing post-stroke will be further investigated by comparing the aphasic participants to a larger age-related normative sample of 80 non-brain-damaged participants. A detailed analysis of pre-morbid handedness and reported visual and/or motor deficits post-stroke that may influence accuracy on the TEA tests will be carried out. The specific research questions are as follows:

a) Is there a significant relationship between the TEA sub-test scores and the RSA questionnaire in the sub-set sample of 9 participants?

b) Is there a relationship between the severity of language and performance on the TEA sub-tests? Do specific language skills such as auditory and reading comprehension show a significant relationship with performance on the TEA sub-tests?

c) Does speed of processing change post stroke in comparison to non-brain-damaged subjects? If so, is there a relationship between speed of processing and performance on the TEA subtests?

d) Is there a relationship between motor and visual impairments and the speed of processing times in aphasic subjects?

2. Method

2.1 Participants

Aphasic participants

16 aphasic participants were recruited via a UCL undergraduate medical student (Bamber 2005) from an acquired language disorders clinic between December 2004 to January 2005. All participants recruited were several years post stroke and had clinically diagnosed aphasia (see table 2.1 for details).

Participants displayed no co-occurring conditions or diseases except aphasia that may have impacted upon their cognitive processing. The only exclusion criteria was failure on the line bisection test (CAT, Swinburn, Porter & Howard 2004). Failure on this test suggests that the client has visual neglect, which may inhibit the participant's performance on the TEA and speed of response test. None of the potential participants were excluded on these grounds. As a result of hemiparesis, four participants were unable to use their preferred pre-stroke hand to complete the tests

Table 2.1: **Aphasic Participant's details**

Participant number	Age	Gender	Time post-stroke (years)	Aphasia classification	Hand used for tests*	WAB data
1	43	F	9	Anomic	P	Yes
2	73	M	11	Anomic	P	Yes
3	34	F	10	Anomic	P	No
4	71	M	11	Anomic	P	Yes
5	56	M	7	Broca's	N	Yes
6	61	M	14	Conduction	P	Yes
7	72	M	4	Broca's	N	No
8	52	M	13	Broca's	N	Yes
9	33	M	4	Broca's	P	No
10	67	M	13	Conduction	P	Yes
11	73	M	14	Conduction	N	No
12	73	F	14	Anomic	P	No
13	71	F	9	Anomic	P	No
14	70	M	12	Wernicke's	P	Yes
15	71	F	13	Anomic	P	No
16	70	F	11	Anomic	P	Yes

* P= preferred, N= non preferred

Non-brain damaged participants

Bamber (2005) administered the speed of processing test to 25 non-brain-damaged participants. The author of this study assessed a further 55 healthy, non-brain damaged participants data bringing the total group size to n = 80(see appendix A). These participant's were aged between 25 and 80 years old (details shown in table 2.2).

Four age bands were defined, based on the grouping of the normative data in the TEA. For each age band, data was collected from a total of 20 non-brain-damaged participants, 10 male and 10 female. The non-brain damaged subjects performance provided age-related normative data to compare the performance of the aphasic participants. Participants did not have aphasia, cognitive or visual impairments that could have impacted upon their performance. All participants were given an information sheet and consent form to sign (see appendix B).

Table 2.2: **Age mean, range and standard deviation of non-brain damaged participants**

	18-34		35-49		50-64		65-80	
Sex	M	F	M	F	M	f	M	F
Mean age	24	26	40	42	56	58	74	70
Standard deviation	3.8	3.7	5.1	5.3	3.1	4.7	5.1	3.6
Range	12	13	14	14	10	14	15	11
N	10	10	10	10	10	10	10	10

2.2 Design

Aphasic Participants

Bamber (2005) used a within subjects design in which participants were exposed to all conditions. The participants were individually administered three tests; the map search, the telephone search and the " speed of processing test". The speed of processing test was devised to measure speed and visual and motor processing (see procedure section). The order in which the tests were presented was randomly varied to control for the effects of fatigue and practice.

For the current project a subset of 9 participants were identified who had undertaken a western aphasia battery assessment (see table 2.1 for further details). Aphasia classification and severity language scores were obtained via the client's files.

Non-brain damaged participants

A between subject's design was used in which participants were exposed to one condition. Participants were individually administered the "speed of processing test" to provide normative data on this measure (see procedure section).

2.3 Procedure

Bamber (2005) collected data on the following measures

:

2.3.1. The Telephone and Map test

These sub-tests of the Test of Everyday Attention (Robertson et al, 1996) are claimed to be sensitive to visual selective attention. Participants were required to circle knife and fork "restaurant" symbols on a map as quickly as possible within two minutes. The test is scored according to the number of symbols circled in one minute ("one minute score") and the total number circled in two minutes ("two minute score"), with the maximum score possible being 80. The telephone test involves subjects searching for pairs of symbols (2 adjacent squares, circles or triangles) in a simulated telephone directory. The test is scored by dividing the time taken to complete the sub-test by the number of correct responses. The map test is a single feature task, involving attention to be directed to the "restaurant" symbols. The telephone task is a feature conjunction task, requiring attention to be directed to each shape. The participant must then make a decision whether these two shapes are identical.

Both tests were administered as according to the TEA manual but with one exception; Instruction's for the map and telephone search tests were simplified to ensure that the participant's language impairments would not inhibit their performance. All other aspects of administration, scoring and analysis of the TEA were followed.

2.3.2 Rating scale of Attentional Behaviour (RSA)

The rating scale of Attentional Behaviour (Ponsford & Kinsella 1992) (see appendix C) comprises of a questionnaire to measure functional attention. Questions investigate selective, divided and focused attention and give an overall total score for attentional behaviour.

2.3.3 The 'Speed of Processing Test'

The Speed of Processing Test was devised as part of Bamber's (2005) study in order to measure speed of visual and motor processing. Speed of visual and motor processing is critical to the TEA sub-test score's. The Speed of Processing Test is based upon the TEA Map Search Test, using symbols of identical size and distribution, with the distracting visual information (the map background) removed. The stimulus sheet was derived from the scoring template for the version of the Map Search displaying petrol pump symbols. Materials required for this assessment were the stimulus sheet, pens for participants to circle symbols and a stop watch to measure time taken.

On this measure, Bamber (2005) collected data from the 16 aphasic participants and for 25 non-brain-damaged participants. For the current study a further 55 non-brain damaged participants carried out this assessment. Participants were asked to circle the symbols as quickly as possible. Bamber (2005) had the initial intention to follow the same procedure as for the Map Test, that is calculating a "one minute" and a "two minute score". After one minute, the stopwatch was briefly stopped while the participant was handed a different coloured pen. Timing was then re-started. During assessment, it quickly became apparent that the majority of aphasic participants were taking less than two minutes to circle the full set of 80 stimuli. The scoring was therefore modified. The mean time per target was calculated from the total time taken to complete the test divided by the number of targets circled.

To collect the normative data, the non-brain damaged participants were instructed to circle all stimuli as quickly as possible. The test was scored as for the participants with aphasia. Full details of the Instructions for the speed of processing test, telephone test and map test are given in appendix D

2.3.4 Language measures

For the current study, three measures were calculated:

1) Severity language score: This measure provided an indication of overall severity of language difficulties. Due to missing data on the object-naming test, it was not possible to calculate a standard WAB aphasia quotient. The severity language score included all oral language sub-test scores excluding the object-naming test. The severity language score was calculated based upon the standard aphasia quotient calculation (see appendix E) for further details). The maximum score is 100.

2) Auditory comprehension score: This measure provided an indication of auditory comprehension skills. The auditory comprehension score was calculated using all auditory verbal sub-tests. The maximum score is 200.

3) Reading score: This measure provided an indication of written comprehension skills. As reading data was inconsistent between participants, reading sentences was selected being the only completed sub-test for all participants. The maximum score is 40.

3. Results

The following section provides a summary of Bamber (2005) results:

3.1 **Visual selective attention tests (TEA) and the rating scale of attentional behaviour (RSA): n= 16 aphasic participants**

The data obtained from the 16 aphasic participants who took part in the study by Bamber (2005) are given in table 3.1. The data includes scores from the TEA map and telephone test and the Rating Scale of Attentional Behaviour (RSA). The rating scale of attentional behaviour comprises of a questionnaire to measure functional attention in aphasic participants. Total overall scores for the RSA questionnaire are shown. The higher the score on this assessment indicates a greater attention impairment. The RSA SA score is based on the items in the questionnaire that load upon selective attention factors.

The map and telephone test both measure visual selective attention impairments. The two-minute map test score is calculated by adding the number of targets circled in the second minute to the number identified in the first minute. Scores for the telephone test are calculated by counting the number of correctly detected symbols and ignoring any false targets. The time taken is divided by the number correctly identified to give time per target score.

The TEA provides age banded normative data. Scaled scores for the TEA subtests are calculated using transformations of each raw score to a 19-point scale given in the appendix of the TEA manual.

Participant	Map (two minute scaled score)	Telephone scaled score	RSA total score / 56	RSA SA Score / 20
1	3	4	10	10
2	7	8	11	7
3	0	0	24	15
4	7	5	16	9
5	8	4	16	9
6	7	4	12	9
7	7	6	15	11
8	5	0	21	13
9	4	8	10	5
10	10	0	16	12
11	12	0	9	5
12	18	11	4	4
13	12	12	9	6
14	6	6	7	3
15	0	0	24	20
16	0	5	23	15

Table 3.1: **Aphasic participants TEA and RSA scores**

Bamber (2005) found significant correlation's using a spearman's rank analysis between:

- Telephone scores and RSA total scores, $r_s(16) = -0.619$, $p = 0.05$ (two–tailed test)

- Telephone test and RSA selective attention (RSA SA) scores rs (16) = - 0.624, $p<0.01$ (two-tailed test)
- Map 2 minute sub-test and the RSA total score, rs(16)= -0.596, $p<0.05$ (two-tailed test).
- Map 2 minute and RSA SA , rs (16)= -0.606, $p<0.05$ (two-tailed test)

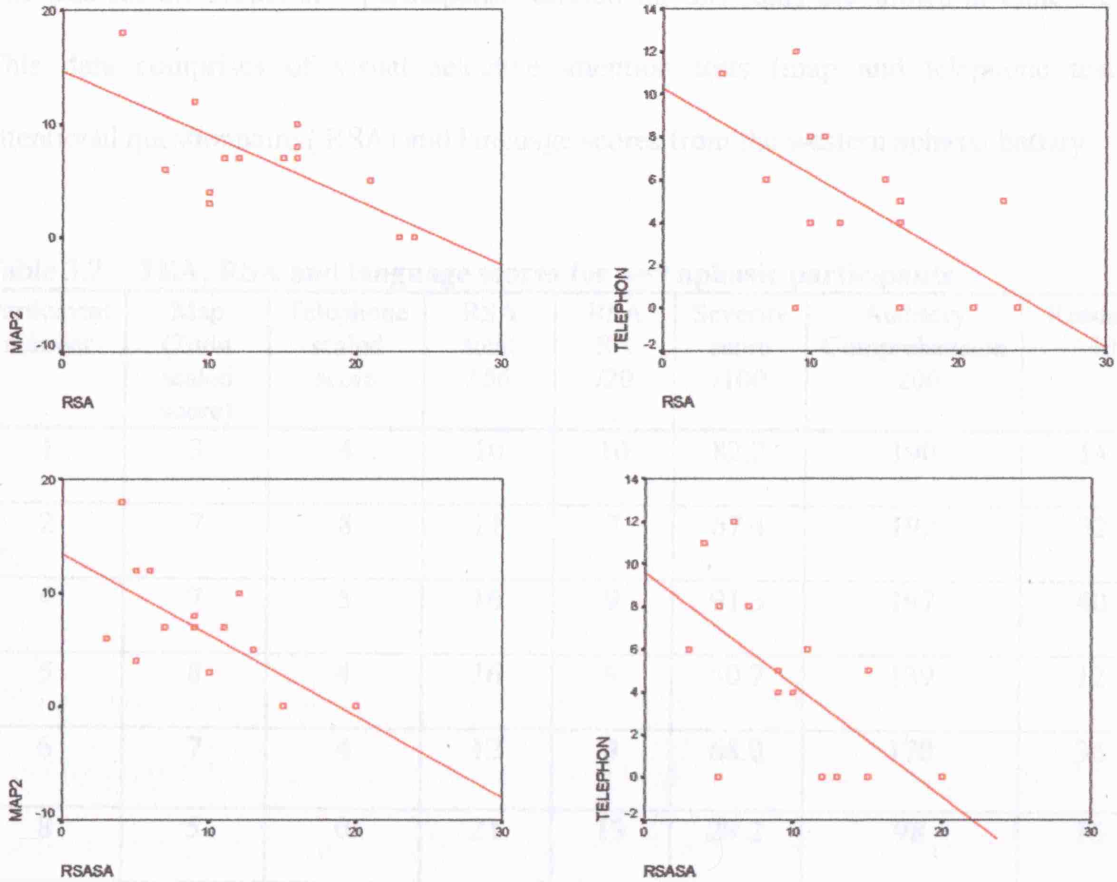
Figure 3.1. comprises of four scatter graphs illustrating the significant relationships found for the 16 participants. The negative correlation's between the TEA sub-tests and the RSA scores are shown. This indicates that as the scores on the TEA tests increase, RSA scores decrease. For example, the poorer the score on the map test, the greater the observed functional impairment. This same relationship exists between the telephone test and the RSA and the telephone test and RSA SA scores. The map test and the RSA SA show a highly significant relationship.

However, no significant correlation was found between map test scores and the telephone test.

Figure 3.1 : Scatter diagrams illustrating the relationships found between TEA and RSA tests for 16 participants

a) Scatter diagram of map scores and RSA scores

b) Scatter diagram of telephone score and RSA scores



c) Scatter diagram of map test and RSA SA scores

d) Scatter diagram of telephone scores and RSA SA scores

The following sections provide results and analysis for the current study:

3.2 Results for visual selective attention tests (TEA), attentional questionnaire(RSA) and language scores for the sub-set of aphasic participants (n=9)

The data for the subset of 9 participants selected for this study are shown in table 3.2 . This data comprises of visual selective attention tests (map and telephone test), attentional questionnaire (RSA) and language scores from the western aphasia battery.

Table 3.2: **TEA, RSA and language scores for n=9 aphasic participants**

Participant number	Map (2min scaled score)	Telephone scaled score	RSA total / 56	RSA SA /20	Severity score /100	Auditory Comprehension /200	Reading / 40
1	3	4	10	10	82.2	190	14
2	7	8	11	7	67.4	192	32
4	7	5	16	9	91.3	197	40
5	8	4	16	9	50.7	139	12
6	7	4	12	9	68.0	170	36
8	5	0	21	13	29.2	98	16
10	10	0	16	12	57.1	137	12
14	6	6	7	3	71.7	154	18
16	0	5	23	15	86.8	196	32

Severity of language scores are calculated from the oral language scores comprising of expressive and receptive language subtests. Scores show a wide range of language skills between participants, from 29.2 to 91.3 out of a maximum score of 100. A lower severity score indicates poorer language skills.

Spearman's rank analysis correlations for TEA, RSA and language data are shown in table 3.3 below

The analysis that follows corresponds to the project aims (1-4):

3.2.1

a) Is there a significant relationship between the TEA sub-test scores and the RSA questionnaire in the sub-set of 9 participants?

For the sub-set of nine participants, results showed no significant correlation between both the TEA sub-tests and RSA scores. This differs from Bamber's (2005) findings, which revealed a significant correlation between these measures for the whole group of 16 participants. However, significant correlation's were still found between the RSA scores and RSA SA scores $r_s (9) = 0.873, p<0.01$ indicating that selective attention factors in the questionnaire increase with the overall RSA score.

Table 3.3: **Spearman's rank correlations between TEA sub-tests, RSA and language scores**

	Map2	Telephone	RSA total	RSA SA score	Severity score	Auditory comp.	Reading
Map2 Correlation coefficient	1	-0.441	-0.349	-0.581	-0.441	-0.339	-0.265
Sig (2 tailed)	0	0.235	0.357	0.101	0.235	0.372	0.491
Telephone Correlation coefficient		1	0.244	0.149	0.667*	0.806**	0.581
Sig (2 tailed)		0	0.528	0.703	0.05	0.009	0.101
RSA Correlation coefficient			1	0.873**	0.192	0.142	0.253
Sig (2 tailed)			0	0.002	0.62	0.715	0.511
Rsa sa Correlation coefficient				1	0.361	0.202	0.169
Sig (2 tailed)				0	0.339	0.603	0.663
Severity Correlation coefficient					1	0.9**	0.689*
Sig (2 tailed)					0	0.001	0.04
Auditory comp Correlation coefficient						1	0.672*
Sig (2 tailed)						0	0.047
Reading Correlation coefficient							1
Sig (2 tailed)							0

* correlation is significant at the 0.05 level (two tailed)

** Correlation is significant at the 0.01 level (two-tailed)

3.2.2

b) **Is there a relationship between the severity of language and performance on the TEA sub-tests? Do specific language skills such as auditory and reading comprehension show a significant relationship with performance on the TEA sub-tests ?**

The telephone test and the Severity of language scores showed a statistically significant relationship rs (9) = 0.7, $p< 0.01$ (two-tailed test). The positive relationship is illustrated in figure 3.2.. This relationship shows that as language severity scores decrease, telephone scores decrease.

A highly significant relationship was found between the telephone test and comprehension scores rs (9) = 0.8, $p<0.01$ (two-tailed test). This indicates that as comprehension test scores decrease, so do telephone scores. This relationship is illustrated in figure 3.3.

A highly significant correlation was found between auditory comprehension rs (9)= 0.9, $p< 0.01$ and severity of language scores. A significant correlation was found between reading scores rs(9)= 0.69 , $p< 0.05$ and severity of language scores. This is to be as expected as both of these scores contribute to a large proportion of the severity of language score.

3.2.2

b) **Is there a relationship between the severity of language and performance on the TEA sub-tests? Do specific language skills such as auditory and reading comprehension show a significant relationship with performance on the TEA sub-tests ?**

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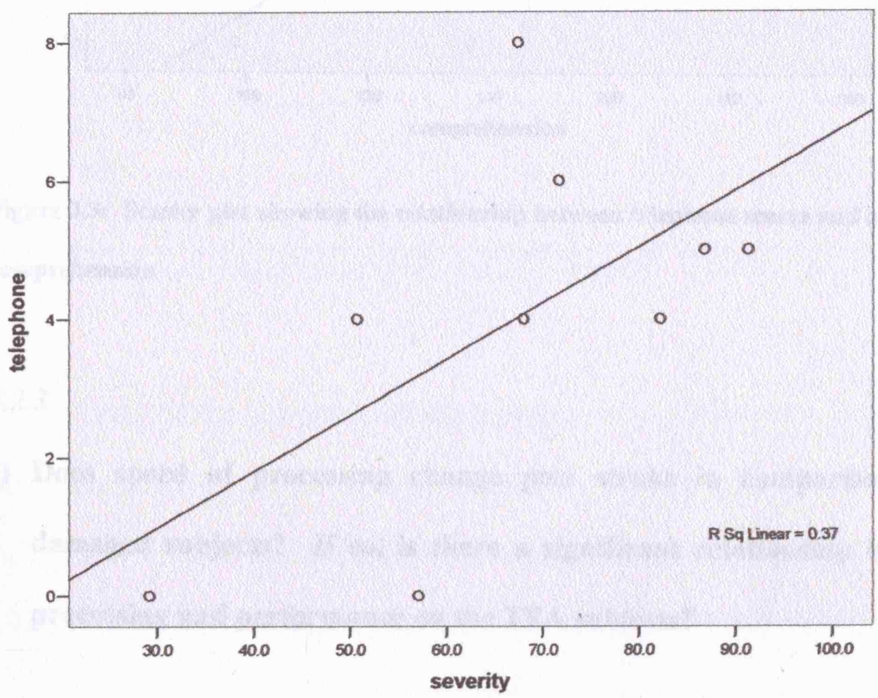
No significant correlation was found between the telephone test and reading scores.

No significant correlation's were found between the map test and any of the language measures. None of the correlation's between RSA scores and language measures proved to be significant.

Figure 3.2 scatter plot showing the relationship between telephone scores and severity of language scores



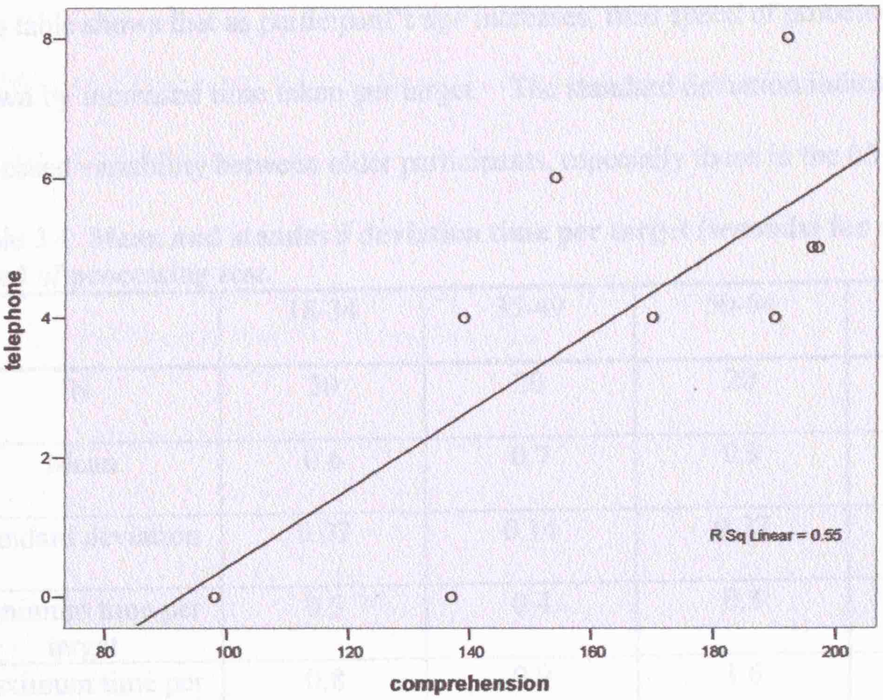


Figure 3.3: Scatter plot showing the relationship between telephone scores and auditory comprehension

3.2.3

c) Does speed of processing change post stroke in comparison to non-brain-damaged subjects? If so, is there a significant relationship between speed of processing and performance on the TEA subtests?

The data obtained from the speed of processing test is shown in Table 3.4. The mean and standard deviation for time per target (seconds) in each age band is shown. For further details of non-brain damaged participants see appendix A .

This table shows that as participant's age increases, their speed of processing decreases as shown by increased time taken per target. The standard deviation indicates that there is increased variability between older participants, especially those in the 65-80 age range.

Table 3.4: **Mean and standard deviation time per target (seconds) for normals on the speed of processing test.**

	18-34	35-49	50-64	65-80
N	20	20	20	20
Mean	0.6	0.7	0.9	1.2
Standard deviation	0.07	0.14	0.27	0.38
Minimum time per target	0.5	0.4	0.5	0.7
Maximum time per target	0.8	0.9	1.6	2.1
< 80 symbols*	1	1	7	6

* Number of participants circling less than 80 symbols

The accuracy of the non-brain damaged participant's performance is shown (number of participants circling less than 80 symbols) in table 3.4. It shows that a number of participants in each age band did not manage circle all symbols. This indicates that within the non-brain-damaged population, it is normal to miss targets. The table shows that as age increases, there is a greater the number of participants missing target symbols.

A one way Anova analysis of age and time per target revealed significance $F= 24.33$, $p< 0.01$ (two tailed test). Levene's test revealed that variance's for this data were not homogeneous. However, this large sample size of 80 participants ensured that the analysis of variance was robust.

A Multiple comparison Bonferroni test was carried out to investigate differences between age-groups (see table 3.5)

Table 3.5 : **Bonferroni test examining age groups for non-brain damaged participants on the speed of processing test**

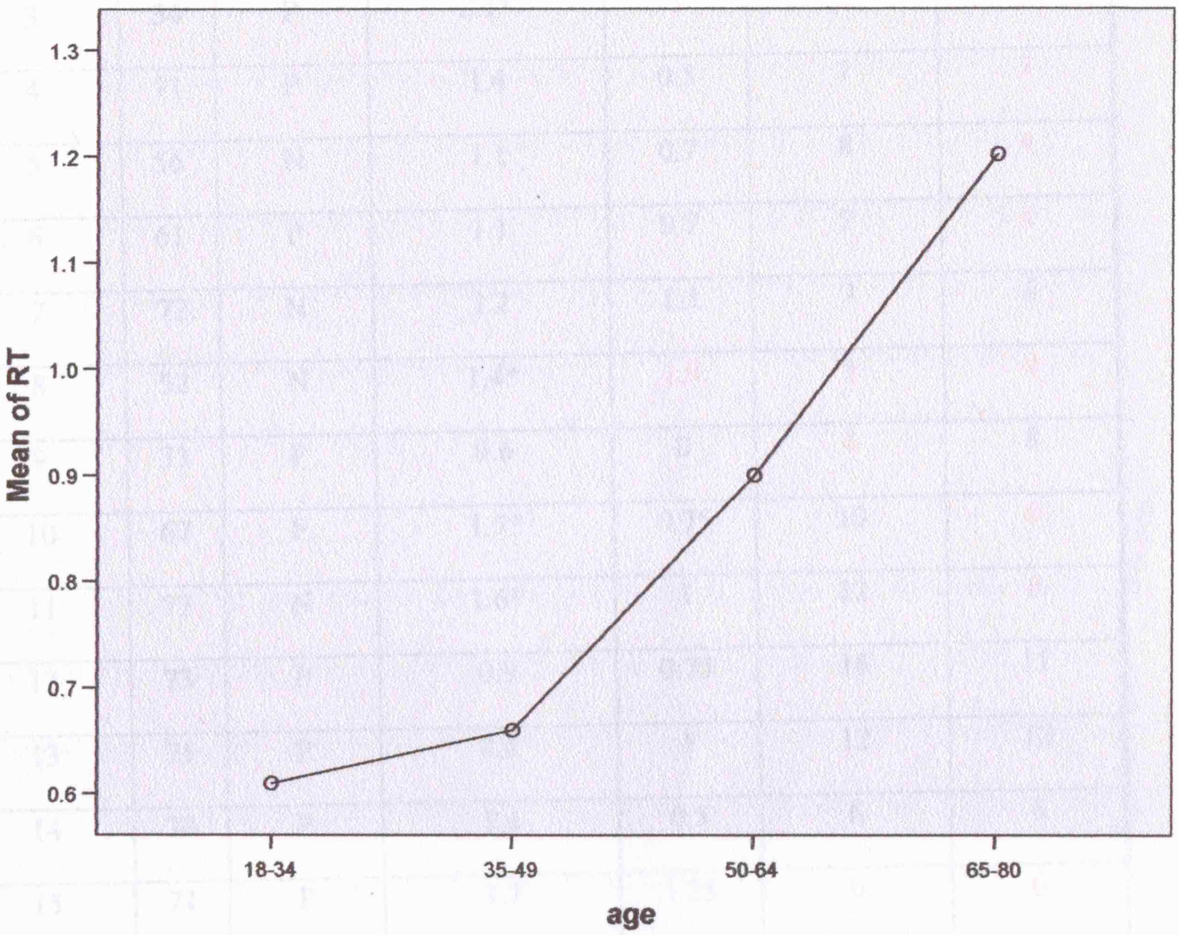
Dependant Variable: Reaction time – time per target (seconds)

(I) age	(J) age	Mean difference (I-J)	Std. Error	Sig	95% confidence interval	
					Lower bound	Upper bound
18-34	35-49	-0.050	0.776	1	-0.260	-0.160
	50-64	-0290*	0.776	0.002	-0.500	-0.802
	65-80	-0.592*	0.776	0.001	-0.802	-0.382
35-49	18-34	-0.500	0.776	1	-0.160	0.260
	50-64	-0.240*	0.776	0.017	-0.450	-0.030
	65-80	-0.542*	0.776	0.001	-0.752	-0.332
50-64	18-34	0.290*	0.776	0.002	0.080	0.500
	35-49	0.240*	0.776	0.017	0.030	0.450
	65-80	-0.302*	0.776	0.001	-0.512	-0.092
65-80	18-34	0.5920*	0.776	0.001	0.382	0.802
	35-49	0.5420*	0.776	0.001	0.332	0.752
	50-64	0.3020*	0.776	0.001	0.092	0.512

* The mean difference is significant at the $p<0.05$ level

The table shows that only age groups a) 18-34 and b) 35-49 have no significant relationship. A highly significant relationship is shown between all other groups. A means plot is provided to illustrate this relationship (Figure 3.4).

Figure 3.4 : **Means plot illustrating the relationship of between age groups.**



The data for the 16 participants obtained for the Speed of Processing Test is shown in table 3.6 below.

Table 3.6: **Aphasic participants performance on Speed of Processing Test**

Participant	Age	Hand used **	SOP time per target (secs)	SOP Z-score	Map 2 minute	Telephone
1	43	P	1.3	3	3	4
2	73	P	1*	-0.5	7	8
3	34	P	2.1*	3	0	0
4	71	P	1.4	0.5	7	5
5	56	N	1.1	0.7	8	4
6	61	P	1.1	0.7	7	4
7	72	N	1.2	1.1	7	6
8	52	N	1.4*	1.9	5	0
9	33	P	0.6	0	4	8
10	67	P	1.5*	0.75	10	0
11	73	N	1.6*	1	12	0
12	73	P	0.9	0.75	18	11
13	71	P	0.8	1	12	12
14	70	P	1.4	0.5	6	6
15	71	P	1.7	1.25	0	0
16	70	P	2.4*	3	0	5

* Circled less than 80 items

* * P= preferred hand
N= non preferred

The speed of processing (SOP) time per target is calculated by dividing the total time taken by the number of targets (80). Where a participant's score falls outside normal limits on a test, this has been highlighted in red in the table.

The scores for the TEA subtests are calculated using transformations of each subtest to a 19 point scale, which corresponds to a range of + or – 3 standard deviations of a matched normal distribution with a mean performance of 10. According to the TEA manual, a scaled score less than 5 is equivalent to performing at the 5th percentile. The Speed of Processing Test used the same 5th percentile cut-off to interpret the aphasic participant's performance. If a participants Z score was greater than 1.65, the equivalent to $p<0.05$ (one-tailed test), they were considered to be performing outside normal limits.

The table shows that four aphasic participants performed below normal limits on the speed of processing test. These four participants all were significantly impaired on the telephone and map test. Two participants that were impaired on the map test were able to circle all targets at a normal speed when the visual selective attention element was removed from the test. Five participants that scored within normal limits on the map test, performed poorly on the telephone test. One participant was able to score within normal limits both on the speed of processing and the telephone test but was significantly impaired on the map test. Five of the 16 participants scored within normal limits on all three measures.

3.2.4

d) Do motor and visual impairments impact upon speed of processing times in aphasic subjects?

Table 3.7 gives details of participant's motor and visual impairments that may have impacted upon their performance. Further case history data detailing factors that may have impacted upon their performance is provided. The four participants details that scored outside normal limits on the speed of processing test are highlighted in Table 3.7. Of the four participants, two have a visual or motor impairment. Participant 1 suffers from right visual field loss that may have impacted upon their performance. Participant 8 suffers from right hemiparesis and was the only one of the four to use their non-preferred hand.

An additional two participants had hemianopia and scored within normal limits on the speed of processing test. A further four participants suffered from either hemiparesis or hemiplegia and were able to circle the targets at a normal speed. Of these four, two used their non-preferred hand. One participant that scored outside normal limits was suffering from Lupus. This medical condition causes a great deal of pain for the individual and may have impacted upon their poor performance on all tests.

Table 3.7: **Aphasic participant's visual and motor impairments**

Participant Number	Hand used*	Visual impairment	Motor impairment	Additional information	SOP Z –score	Map 2 min	Telephone test
1	P	R visual field loss	--		3	3	4
2	P	--	R hemiparesis		-0.5	7	8
3	P	--	--	Lupus	3	0	0
4	P	R hemianopia	--	Memory difficulties	0.5	7	5
5	N	--	R hemiplegia		0.7	8	4
6	P	R hemianopia	--		0.7	7	4
7	N			Hearing loss	1.1	7	6
8	N	--	R Hemiparesis		1.9	5	0
9	P	--	--		0	4	8
10	P	--	R hemiparesis	Hearing loss	0.75	10	0
11	N	--	R hemiplegia	Hearing loss	1	12	0
12	P				0.75	18	11
13	P		--		1	12	12
14	P	--	--		0.5	6	6
15	P	--	--	Memory difficulties	1.25	0	0
16	P	--	--	Hearing loss	3	0	5

* P= preferred hand, N= non-preferred

4. Discussion

4.1 Discussion of analyses

The following discussion will involve examining the four aims outlined in the introduction. Limitations in the method adopted by the study and recommendations for further research are discussed.

The first aim of the study was to investigate the relationship between the TEA sub-test scores and the RSA questionnaire in the sub-set sample of 9 participants. Findings revealed no significant correlation found between the TEA sub-tests and the RSA questionnaire for the smaller sample of participants (n=9). However, there was significant correlation found for the data comprising of 16 participants (Bamber 2005). The following analyses outline the relationships between the TEA and RSA scores from this sample of 16 participants.

A significant relationships was found between the map test and RSA overall score rs (16) = -0.596, $p<0.05$. The positive correlation's found between the map test and the RSA scores are consistent with similar investigations by Robertson (1996). (see literature review) There was also a highly significant correlation between the telephone test and RSA overall score rs(16)= -0.619, $p<0.05$. This indicates that the TEA visual selective attention sub-test's correspond to the RSA measures.

A significant relationship was found between map test scores and RSA SA scores, $r_s\ (16) = -0.606$, $p=0.05$ and the telephone test and RSA SA scores , $r_s(16)= 0.624$, $p<0.01$. This indicates that visual selective attention measured by the TEA sub-tests corresponds to the selective attention factors measured by the RSA.

These significant correlations suggest that the TEA sub-tests may provide the clinician with an accurate measure of selective attention. It also suggests that visual selective attention tasks may be an effective measure to detect attentional impairments in the aphasic population. As no significant relationship found for these measures in the smaller sample of nine participants, this suggests that the sample was too restrictive.

The RSA comprises of components loading on divided and sustained attention, and some participants achieved high scores on these aspects of attention. Such difficulties in attention are common among the aphasic population (see literature review). The co-occurrence of these deficits may have impacted upon the participant's performance on these tests and this area would require further research. Therefore, it may be difficult to separate these aspects of attention to measure selective attention in the aphasic population.

There was no significant correlation found between the map and telephone test. As both these tests purport to measure visual selective attention, this finding is surprising. The data shows that while only six out of 16 participants scored below normal limits on the map test, ten out of the 16 were found to be significantly impaired on the telephone test.

Further consideration of these two tests possibly provides an explanation for these differences. The map test involves single feature detection where the symbols 'pop out' from the scene. The telephone test requires participants to match two abstract symbols and involves a decision-making component. The analyses showed a highly significant relationship between the telephone test and two of the language measures, suggesting that linguistic impairments may be influencing test scores on this sub-test.

The second aim of the study was to investigate the relationship between severity of language and performance on the TEA sub-tests. Specific language skills such as auditory and reading comprehension would be examined in relation to performance on these tests.

There was a significant relationship between the telephone test and severity of language skills $rs(9)= 0.7$, $p<0.01$. This relationship indicates that as scores on the telephone test decrease, language scores also decrease. A highly significant correlation was also found between the telephone test and auditory comprehension scores $rs(9)= 0.8$, $p<0.01$. This indicates that as telephone scores decrease, language scores also decrease. Auditory comprehension scores and overall severity scores are inter-correlated. These finding suggest that it may be important to consider auditory comprehension abilities when interpreting performance on the telephone test.

The instructions for the telephone test, despite modifications, are lengthy and more complex than for the map test. The aphasic participants may have been confused by these instructions, becoming anxious and hesitant thereby negatively impacting upon their performance.

No significant relationship was found between the map test scores and the language measures. This suggests that the map test may be more suitable measure of visual selective attention for the aphasic population than the telephone test.

Reading scores and the TEA tests revealed no significance. This may have been due to the small restrictive sample of only 9 participants. A larger sample may potentially reveal such a relationship.

There was no significant correlation between the RSA scores and language measures. Such a relationship may become apparent if a larger sample of participants were investigated. Certain attentional factors to be rated in the questionnaire have language elements. Word retrieval difficulties are common in the aphasic population, resulting in behaviour such as 'staring into space for long periods' (RSA) while the individual searches for the target word. The RSA is open to interpretation by a clinician, and grading may differ if they consider certain attentional factors to be linguistic in nature. Once again, the sample may have been too small to reveal such a relationship and future research involving a larger sample would be recommended.

The third aim to be investigated was whether speed of processing changes post stroke in comparison to non-brain-damaged subjects. Relationship between speed of processing and performance on the TEA sub-tests were to be examined.

Analysis of variance demonstrated a highly significant relationship between age and time per target (seconds) score on the speed of processing test. This suggests that with increased age there is a reduction in the speed that this test can be executed. The subsequent multiple comparisons revealed significant differences in processing speed between all groups except the 18-34 and 35-49 age groups.

Four aphasic participants scored outside normal limits on the speed of processing test. As their performance differs from the normal age-related changes observed in the non-brain -damaged participants it can be hypothesised that these individuals are presenting with speed of processing changes that relate to their stroke. These four individuals also scored outside normal limits on the map and telephone test. Their poor performance on the TEA subtests could therefore be accounted for, at least in part, by their generally slow response times in such assessments. It is therefore difficult to conclude to what extent these participants are presenting with visual selective attention difficulties per se. Robertson et al (1996) acknowledges that speed of processing may play a part in these assessments. This project has highlight that it is important for clinicians to consider the issue of speed of processing when using timed assessments such as the TEA sub-tests.

Two participants who were impaired on the map test were able to circle all targets at a normal speed on the speed of processing test. As speed of processing is not impacting upon their performance on the map test, it can be hypothesised that these two participants have visual selective attention deficits.

Five participants that scored within normal limits on both the speed of processing and map test performed poorly on the telephone test. This dissociation between good performance on the map test and poor performance on the telephone test would seem to support the finding that language impairments may be impacting upon performance on the telephone test. It may also be of note that, of these five, two participants suffer from short-term memory difficulties. These memory difficulties may impact upon the participant being able to remember the telephone tests lengthy verbal instructions and the purpose of the task.

The final aim was to investigate the relationship between motor and visual impairments and the speed of processing times in aphasic subjects. Of the four participants to score outside normal limits on the speed of processing test, only two suffered from a visual or motor impairment. One participant suffered from right visual field loss. Robertson *et al.* (1996) acknowledges that individuals may have difficulty in detecting symbols because of visual impairments. There is additional evidence to suggest that reaction times are increased by hemianopia (Gerristen 2003). However, two of the participants that suffer from such impairments and were able to circle the targets at a normal speed. One participant that scored outside normal limits suffered from hemiparesis. Such a weakness can compromise performance on tests that require fine motor skills (Van Mourik *et al* 1992). However, four other participants suffering from a similar impairment were able to circle at a normal speed.

The findings from the speed of processing test are unclear as for some participants; their significant determinant of speed may be due to their visual and motor impairments. Further research investigating the severity of a participant's impairment and the impact on such assessments is required. If these impairments are a significant factor, clinicians considering assessment of their client using the TEA sub-tests and may have to select alternative tests. As outlined in the literature review, speed of processing may arise from attention impairments. Further research may clarify the complex issue of identifying attention, motor and visual elements when interpreting assessment results.

4.2 Discussion of method

There are limitations in the method adopted in this study. The smaller sample of nine participants did not reveal significant correlation's between the TEA sub-tests and the RSA questionnaire. Future research should involve recruitment of a larger sample of aphasic participants that have undertaken the WAB (Kertsz, 1982) assessment. Language measures such as severity score and reading score were calculated due to inconsistent and missing data for the participants. A comprehensive assessment would allow for the standard calculation of the aphasia quotient for analysis.

Conclusion

In the larger sample of 16 participants, there was a significant relationship between the TEA sub-tests and the RSA. These findings suggest the TEA sub-tests would be a suitable tool for the clinician to assess selective attention impairments in the aphasic population. However, highly significant correlations were found between the telephone test and language measures, suggesting that linguistic impairments may be affecting performance. As the map test revealed no such relationships, this sub-test would allow the clinician to identify attentional deficits not influences by language impairments.
Speed of processing was shown to decrease post-stroke in some aphasic participants and influenced their performance on the TEA sub-tests. Two participants were identified with visual selective attention impairments. This finding will allow the clinician to assess and treat attentional impairments in these clients (see Murray 2002). The extent to which visual and motor processing influenced performance on the speed of processing test remains unclear and should be investigated further.

Word count: 8855

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Appendix A

Ages 18-34

Participant	Age	Gender	Total time (sec)	time per target* (sec)
1	19	f	58	0.7
2	20	m	62	0.8
3	21	m	59	0.7
4	22	f	40	0.5
5	25	m	42	0.5
6	25	m	45	0.6
7	25	f	47	0.6
8	25	f	47	0.6
9	25	f	43	0.6
10	26	f	51	0.6
11	26	f	43	0.6
12	27	m	49	0.6
13	27	m	43	0.6
14	28	m	56	0.7
15	28	f	45	0.6
16	30	m	47	0.6
17	30	f	44	0.6
18	31	m	41	0.5*
19	32	m	46	0.6
20	32	f	45	0.6

Ages 35-49

Participant	Age	Gender	Total time (sec)	time per target* (sec)
21	35	m	43	0.5
22	35	f	33	0.4
23	35	f	61	0.8
24	36	m	46	0.5
25	36	m	64	0.8
26	36	m	39	0.5*
27	36	f	59	0.7
28	37	m	46	0.5
29	37	m	64	0.8
30	38	f	55	0.7
31	40	f	57	0.7
32	41	m	59	0.7
33	42	f	63	0.8
34	43	f	42	0.5
35	43	f	37	0.6
36	45	f	49	0.6
37	48	m	59	0.7
38	49	f	63	0.8
39	49	f	66	0.9
40	49	m	59	0.7

Appendix A.

Ages 50-64

Participant	Age	Gender	Total time (sec)	Time per target* (sec)
41	50	m	43	0.5
42	50	f	77	1
43	51	f	76	1
44	52	m	129	1.6
45	54	m	74	0.9*
46	55	f	72	0.9
47	55	m	73	0.9
48	55	f	40.4	0.5
49	56	m	74	0.9
50	57	f	92	1.4
51	57	m	62	0.8*
52	57	f	68	0.9
53	58	m	56	0.7
54	59	m	82	1*
55	60	f	55	0.7
56	60	m	83	1*
57	60	f	43	0.5*
58	61	f	69	0.9*
59	63	f	76	1
60	64	f	66	0.9*

*circled <80 symbols

65-80

Participant	Age	Gender	Total time (sec)	time per target* (sec)
61	65	f	74	0.9*
62	65	m	81	1
63	65	f	73	0.9*
64	67	f	105	1.3
65	68	m	133	1.7
66	69	f	82	1
67	69	f	83	1
68	70	m	82	1
69	70	f	81	1
70	71	f	91	1.1
71	72	f	53	0.7
72	73	m	60	0.8*
73	73	m	128	1.6*
74	74	m	125	2.14*
75	74	f	65	0.8
76	76	f	129	1.61
77	77	m	97	1.2
78	78	m	127	1.6
79	80	m	165	1.6
80	80	m	83	1.1*

Appendix 15

Department of Human Communication Science
UNIVERSITY COLLEGE LONDON
Chandler House · 2 Wakefield Street · London WC1N 1PF
Tel: 020 7679 4200 · Fax: 020 7713 0861
Internet: http://www.hcs.ucl.ac.uk/

Head of Department
Jane Maxim
MA, PhD, DipCST,
Reg. MRCSLT

Information form

Confidential

Title of study: Investigating attention in acquired aphasia

Investigators: Anne Edmundson and Catherine Cawley

Address: Department of Human Communication Science
University College London
Chandler House
2 Wakefield Street
London, WC1N 1PF
Tel: 020 7679 4200

You are being invited to take part in a research study. Before you decide to partake, please read the following information.

This study is a project supervised by the Department of Human Communication Science at University College London. Catherine is a Speech and Language Therapy student.

Following a stroke, people may suffer from visual and motor processing difficulties. When completing an assessment, these difficulties may negatively impact upon their overall score. This project aims to gather data from non-brain damaged participants using a speed of response test. This will allow data comparison with people who have suffered a stroke.

Appendix B

You will be asked to complete a short test. You will be asked to look at a sheet of paper, find some symbols and circle each with a pen. You will be asked to do this as quickly as possible. A stopwatch will be used to time how fast you can complete the test. In order to know how well you performed on these tests, Catherine will need to know your age.

If you decide to take part in this study, you will be asked to sign a consent form. All the data from this study is confidential. You will only be identified by your initials.

Thank you very much for your time,
Anne Edmundson and Catherine Cawley

Appendix B.

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Head of Department
Jane Maxim
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Consent form

Confidential

Title of study: Investigating attention in acquired aphasia

Investigators: Anne Edmundson and Catherine Cawley

Address: Department of Human Communication Science
University College London
Chandler House
2 Wakefield Street
London, WC1N 1PF
Tel: 020 7679 4200

To be completed by the volunteer:	*Circle your answer
• Do you understand that you do not have to take part in this study?	YES/NO*
• Have you read the Information Sheet about this study?	YES/NO*
• Have you asked any questions you have about this study?	YES/NO*
• Have you had enough time to decide whether you want to take part in this study?	YES/NO*
• Do you understand that you do not have to give any reason if you want to stop taking part in this study	YES/NO*
• Do you agree to take part in this study?	YES/NO*

If you have any concerns please speak to the Investigators.

Name of volunteer:..............................

Signature...

Date:...

Name of investigator:...........................

Signature...

Date:...

Appendix C

RATING SCALE OF ATTENTIONAL BEHAVIOUR (RSA)
Therapist……………………. Date …………………..
Could you please answer the following questions about……………………………………
By ticking the boxes which most nearly applies to their behaviour now:

Has…………………recently?	Not at all (0)	Occasion-nally (1)	Some-times (2)	Almost always (3)	Always (4)
1. Seemed lethargic (i.e. lacking energy)					
2. Tired easily					
3. Been slow in movement					
4. Been slow to respond verbally					
5. Performed slowly on mental tasks					
6. Needed prompting to get on with things					
7. Stared into space for long periods					
8. Had difficulty concentrating					
9. Been easily distracted					
10. Been unable to pay attention to more than one thing at a time					
11. Made mistakes because he/she wasn't paying attention properly					
12. Missed impotant details in what he/she was doing					
13. Been restless					
14. Been unable to stick at an activity for very long					

Highlighted areas involve selective attention = RSA SA Total: Score:

Appendix D

Procedure

General introduction to the three tests
I am interested in your concentration. Here is the first test.

Map Search
Equipment
TEA items (Philadelphia Map Version A, Cuebook, Version A template, Scoring sheet), red pen, blue pen, stopwatch and training sheet. The training sheet should be produced by photocopying part of the Map Search Version A scoring template, which only has the knife and fork target symbols on it and no competing stimuli (the label should not be photocopied).

Instructions
(Place cue book and map in front of subject)

This is the symbol for a restaurant
(point to symbol in cuebook)

There are lots of restaurant symbols like this on the map
(point to one on the left side of the map, indicate that they are all over – left, right, top, bottom)

Can you see these?

TURN MAP FACE-DOWN

You need to look at the map and find as many restaurant symbols as you can. Put a circle around each one you find. Do this as quickly as you can.

USE TRAINING SHEET TO DEMONSTRATE

Have a practice on this, as quick as you can
(Give subject red pen and let them practice circling symbols on training sheet)

Okay. Lets try the real thing now.
After 1 minute I will stop you and swap pens.
After another minute, I will ask you to stop.
Do you understand?
(If yes, proceed with test. If not, repeat instructions)

(Turn the map over and give the subject the red pen)
Start now.
(Start stopwatch. After 1 minute, pause stopwatch and give subject blue pen. Ask him/her to carry on and re-start stopwatch. After 2 minutes, stop the subject)

Appendix D

(If the subject feels that they have completed the task before the two minute time limit, or if they assume they have done so by reaching the right hand edge of the map, ask them to continue searching for any symbols which they might have missed until the end of the time limit. Where appropriate, the prompts specified in the TEA manual should be used – they are as follows:

-If the subject feels that they have completed the task before the two minute time limit, or if they assume they have done so by reaching the right hand edge of the map, ask them to continue searching for any symbols which they might have missed until the end of the time limit.

-If subjects talk during this task, thereby slowing their performance, the assessor should try not to respond or simply say '*...remember to find as many as you can...*'. A subject may stop searching after they have found only a few targets, apparently finding it difficult to persist. The assessor should make the same basic comment as above, perhaps with some encouragement: '*...You are doing fine so far, keep finding as many as you can for a bit longer...*' or '*...there are quite a few symbols, can you find any more?*')

Appendix D

Telephone Search

Equipment

TEA items (Directory Page Version A, Cuebook, Scoring sheet), red pen, stopwatch and training sheet. The training sheet should be produced by photocopying part of the telephone directory and should show only 6 pairs of symbols, 4 of which are the same.

Instructions

(Place the directory in front of the subject)

This is like a Yellow Pages telephone directory
(point to directory)

This page is about plumbers.

Can you see these symbols?
(Point to symbols on the directory)

These symbols tell you which are the best plumbers – you are looking for plumbers with 2 symbols the same. Like these (show symbols in cuebook). *Either 2 crosses or 2 stars or 2 squares or 2 circles.* (Leave cuebook open in front of subject)

Here are some practice ones (show training sheet). *Sometimes the 2 symbols are the same, sometimes different* (indicate the same pairs and the different pairs on the training sheet). *When 2 symbols are the same, put a circle round them – like this* (circle the same symbols on the training sheet).

Do you want to have a practice? (If yes, let the subject circle the symbols you have just circled on the training sheet)

Okay. Do you understand?
(If yes, proceed. If no, repeat instructions).

Please do this as quickly as you can. I am going to time how long it takes you to do the whole sheet (indicate that there are four long columns on the directory)

When you get to the end, please put a cross in this box (point to box on the directory)

Ready? Start now.
(Hand subject red pen and start stopwatch. Once subject has finished, do not give prompts to find more of the target symbols. If subject takes more than 4 minutes, terminate the test)

(If you see that the subject has reached the bottom of the fourth column but has not put a cross in the box, confirm that they have reached the end and terminate the test)

Appendix D.

Circles Test

Equipment

A photocopy of the Version C scoring template from the Map Search (excluding the printed label), cuebook (open at petrol station symbol), red and blue pens, a stopwatch.

Instructions

(Place the template photocopy in front of subject)

There are lots of symbols on this sheet.
Please put a circle around each one.
Do this as quickly as you can.
After 1 minute I will stop you and swap pens.
After another minute I ask you to stop.

Do you understand?
(If yes, proceed. If not, repeat instructions)

Ready? Start now.
(Give subject red pen and start stopwatch. After 1 minute, pause stopwatch and give subject blue pen. Ask him/her to carry on and re-start stopwatch. If the subject finishes the task before the 2 minute time limit, the time they have taken should be recorded. If the subject is still working at 2 minutes, stop the subject and the stopwatch, give the subject a pencil, ask them to carry on and re-start the stop watch from 0. You should therefore obtain either a "total time" or ">2min score").
(If the subject feels that they have completed the task before the two minute time limit, or if they assume they have done so by reaching the right hand edge of the map, ask them to continue searching for any symbols which they might have missed until the end of the time limit).
(If subjects talk during this task, thereby slowing their performance, the assessor should try not to respond or simply say '*...remember to find as many as you can...*'. A subject may stop searching after they have found only a few targets, apparently finding it difficult to persist. The assessor should make the same basic comment as above, perhaps with some encouragement: '*...You are doing fine so far, keep finding as many as you can for a bit longer...*' or '*...there are quite a few symbols, can you find any more?*')

Scoring

Count the number of symbols circled in red. This is the one minute score. Then count the number circled in blue and add this to the red total. This is the two minute score.

Appendix E

Calculation of severity score

Spontaneous speech	Maximum
Information content	10
Fluency	10
Total	*20*

Comprehension

Yes/No questions	60
Auditory word recognition	60
Sequential commands	80
Total	
Divide by 20	10

Repetition

Total	
Divide by 10	10

Naming

Word fluency	20
Sentence completion	10
Responsive speech	10
Total	
Divide by 10	10

Add totals and divide by 2 for severity score